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A technique for EBSD analyses of phyllosilicates in petrographic sections and determination of polytypes in lepidolite

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Applications of Electron backscatter diffraction (EBSD) to obtain crystallographic information of minerals in petrographic thin sections are increasing in mineralogy and petrology. However, platy phyllosilicates that mostly appear with their silicate layers terminated by the surface of the thin section generally do not show sharp EBSD patterns in spite of gentle mechanical polishing using colloidal silica. Transmission electron microscopy (TEM) examination indicated that this is due to crystal bending of phyllosilicates from the surface to a few micrometers in depth, caused by the polishing process (Fig. a) . Ion beam etching commonly used to prepare TEM specimens was found to be applicable to remove the surface region with crystal bending (Fig. b and c). As a result, clear and sharp EBSD patterns were acquired from the phyllosilicates (micas, chlorite, etc.) in petrographic thin sections, by which their crystal orientations and polytypes were unambiguously determined. This technique was applied to the determination of polytypes of lepidolite, a lithium-rich aluminous mica whose general composition is expressed as $K(Li, Al)_{2-3}(Si,Al)_4O_{10}(OH,F)_2$.

The mica structure generates six standard polytypes expressed as $1M$, $2M_1$, $2M_2$, $2O$, $3T$ and $6R$. They are divided into two subfamilies: *subfamilies* A and B. $1M$, $2M_1$ and $3T$ are classified into *subfamilies* A, and $2M_2$, $2O$ and $6R$ are classified into *subfamilies* B (Backhaus and Durovic 1984). Using EBSD pattern, it is possible to distinguish the two *subfamilies* (Kogure 2002). We investigated lepidolite from a lithium pegmatite in Myoken-san, Ibaraki, where various polytypes have been reported (Kogure and Bunno 2004). EBSD analyses of lepidolite crystals in petrographic thin sections showed that polytypes with different subfamilies coexist within a single crystal: The outside was $1M$ (*subfamilies* A) and inside was $2M_2$ (*subfamilies* B).

References

Backhaus, K. O. and Durovic, S. (1984) Polytypism of micas. I. MDO polytypesand their derivation. Clays and Clay Minerals, 32, 453-463.

Kogure, T. (2002) Identification of polytypic groups in hydrous phyllosilicates using Electron Back-Scattering Patterns (EBSPs), American Mineralogist, 87, 1678-1685.

Kogure, T. and Bunno, M. (2004) Investigation of polytypes in lepidolite using electron back-scattered diffraction. American Mineralogist, 89, 1680-1684.

Figure

(a) TEM image of muscovite near the polished surface with colloidal silica. Tungsten (W) was coated for surface protection in the FIB process. (b) TEM image of muscovite near the surface etched by ion milling. Pt-Pd and carbon film were coated after ion milling to identify the specimen surface. (c) High-resolution TEM image of the area marked with square in b.

Keywords: EBSD, phyllosilicates, ion milling, petrographic thin section, polytype, lepidolite